MARS EXPLORATION PROGRAM

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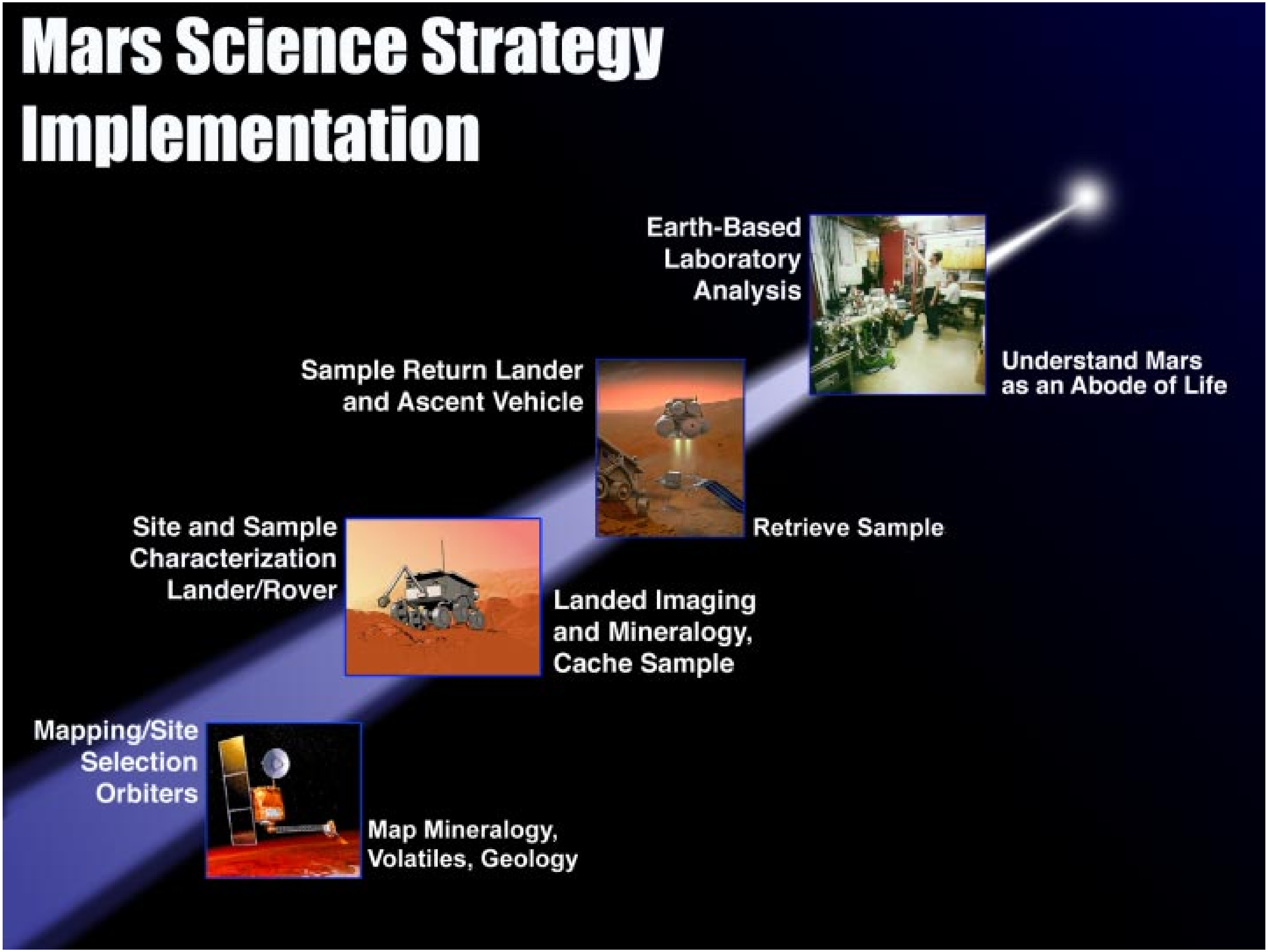
MARS EXPLORATION MISSIONS - 1996-2005

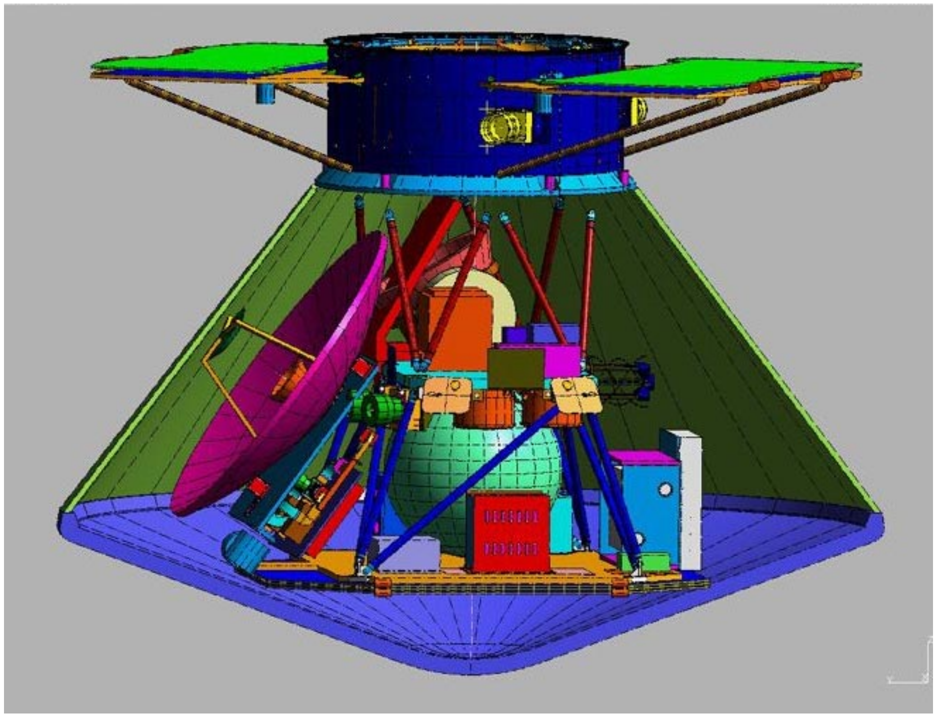
1996	**1998**	**2001**	**2003**	**2005**
Geology & Geophysics	*Water, Volatiles & Climate*	*Global Minerology*	*Surface Operations Support*	*Return Cached Samples to Earth*
Mars Global Surveyor	**Mars Surveyor 1998 Orbiter**	**Mars Geochemical Mapper**	**Mars Surveyor 2003 Orbiter**	**Mars Sample Return**
Lander Technologies; Microrover	*South Polar Terrane*	*Ancient Mars Exploration; Sample Caching*	*Ancient Surface Water Deposits Sample Caching*	
Mars Pathfinder	**Mars Surveyor 1998 Lander: DS-2 Microprobes**	**Mars Surface Exploration Rover/Lander**	**Mars Surface Exploration Rover/Lander**	
	Interaction with Solar Environment	*Phobos & Deimos*		
	Planet B (Japan)	**Aladin (?)**		
		"Mars Together Option"		
		Marsokhod (?) (Russian)		

= NASA Mars Surveyor Progra = NASA Discovery Program = NASA New Millennium Program = International Missions

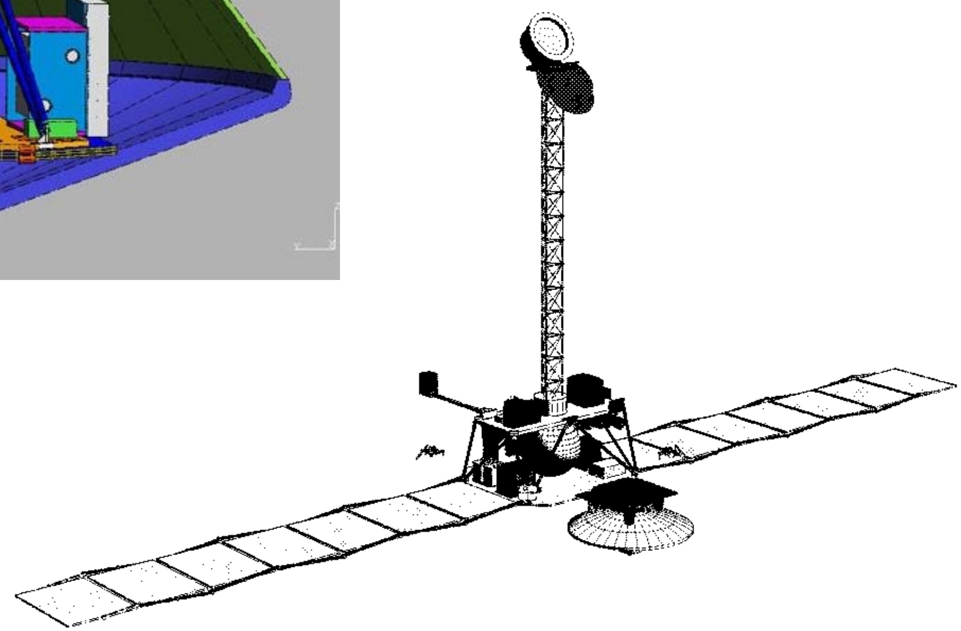

Mars Science Strategy Implementation
Earth-Based Laboratory Analysis
Understand Mars as an Abode of Life
Sample Return Lander and Ascent Vehicle
Retrieve Sample
Site and Sample Characterization Lander/Rover
Landed Imaging and Mineralogy, Cache Sample
Mapping/Site Selection Orbiters
Map Mineralogy, Volatiles, Geology

MGM

Mars Geochemical Mapper



**Aerocapture Orbiter:
Cruise Configuration**



**Aerocapture Orbiter:
Orbiting Configuration**

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PROGRAM

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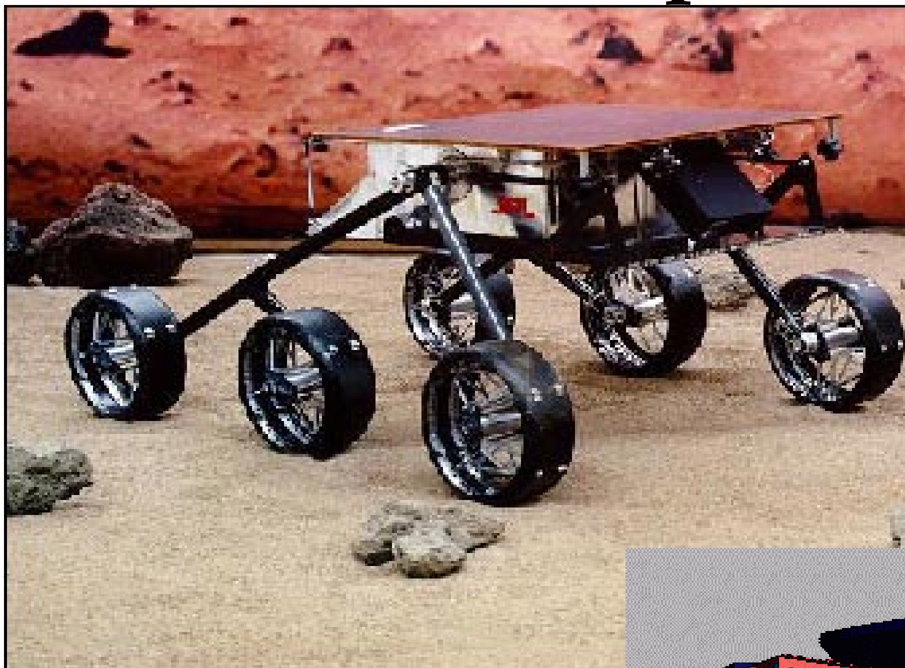
MARS SURVEYOR PROGRAM

Mars Geochemical Mapper

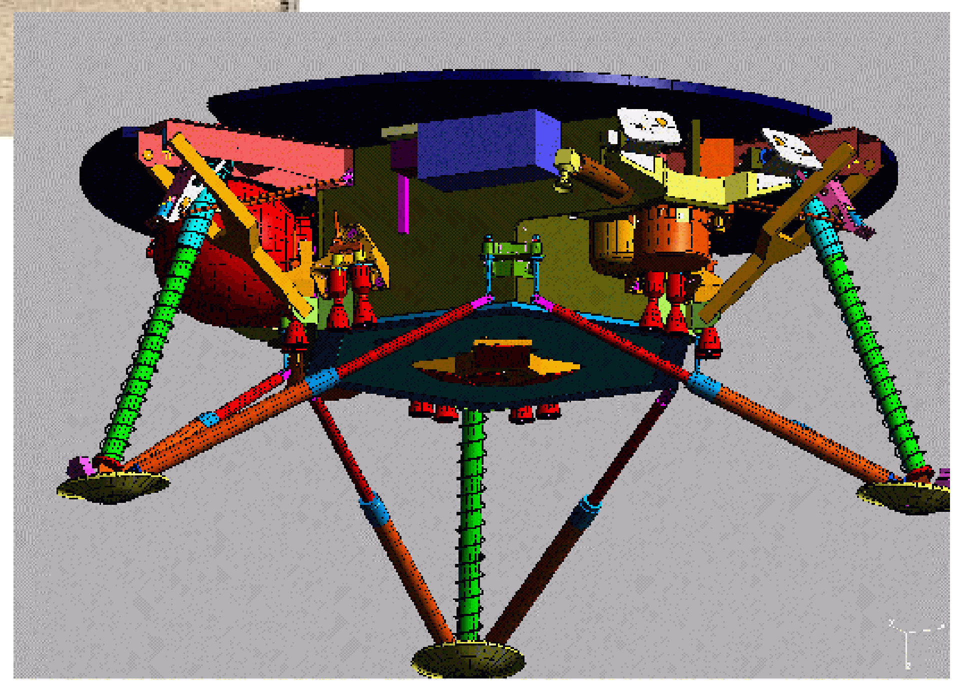
- Science
  - Map elemental composition of Martian surface
  - Find highest concentrations of water (H) in the top meter of the Martian surface
  - High-spatial resolution mineralogy mapping
  - Locate sites of aqueous sedimentation
  - Search for environments conducive for past or present life
  - Radiation measurements
- Mission
  - Launch early 2001, arrive late 2001
  - Med-lite launch vehicle
  - Orbit insertion via aerocapture
  - Polar orbit
  - Communication relay for surface vehicles (5 year life on orbit)
- Technology
  - Aerocapture
  - Small, lightweight remote sensing instruments

MSER

Mars Surface Exploration Rover/Lander



Rover Concept



Lander Concept

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MARS SURVEYOR PROGRAM

Mars Surface Exploration Rover/Lander

- Science
  - Explore and characterize Martian highlands ('01) and second site ('03)
  - Study geologic processes
  - Examine sites of potential exobiologic interest
  - Selection and caching of priority samples for pick up by sample return mission
  - Radiation and dust measurements
- Mission
  - Launch 2001 and 2003, arrival same years
  - Direct entry to Mars, propulsive descent and landing
  - Rover traverse tens of km for one Earth year (semi-autonomous traverse, navigation, and planning)
  - Rover caches sample with beacon for later pick up
  - Rover communicates via relay orbiter
- Technology
  - Autonomous, long-range roving
  - Survivability for long duration over wide temperature ranges
  - Miniature chemistry and mineralogy instruments
  - Sample acquisition and planetary protection
  - Low power/mass communication relay and navigation support
  - Precision landing demonstration (goal of < 10 km)
  - Partial in-situ propellant production demo

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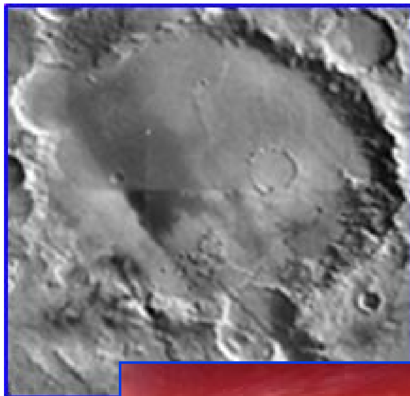
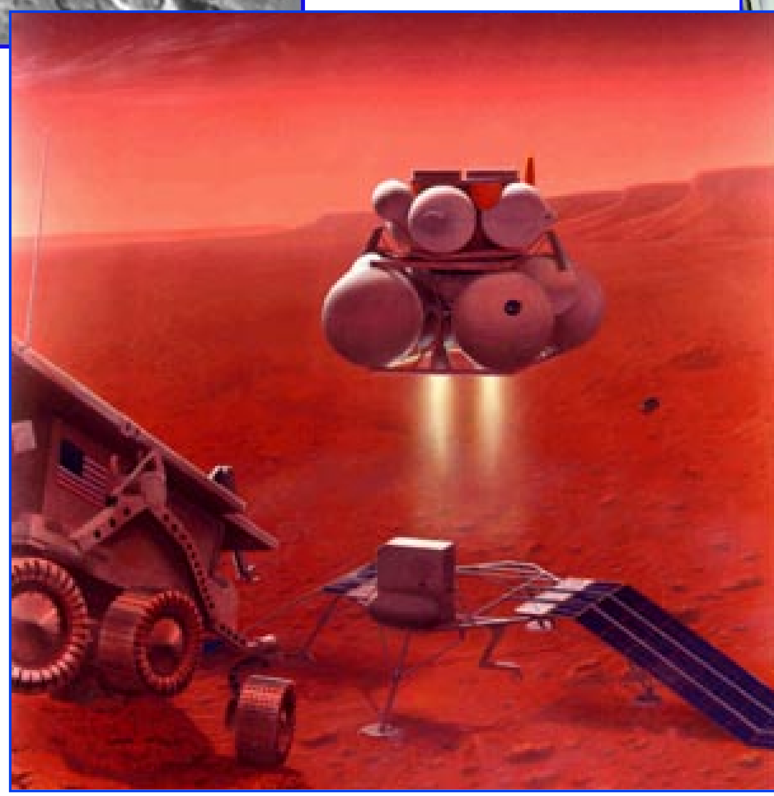
Mars Sample Return





M S R

MARS SURVEYOR PROGRAM

Mars Sample Return

- Science
  - Return samples of Mars rock, soil, and atmosphere to Earth
  - Samples selected by 2001, 2003 Rover missions
  - Analyses on Earth to determine the age, origins, and potential biotic or prebiotic activity
  - Follow-on analyses to discriminate hypotheses of the evolution of Mars
  - Samples provide for continuous, low-cost science return for many years
- Mission
  - Launch late 2004 or mid-2005, sample on Earth mid-2008.
  - Land near and retrieve previously cached sample, about one kilogram.
  - Short surface stay, days to weeks (longer if manufacturing propellant)
  - Lowest cost approach under study, e.g. direct surface to Earth versus orbit rendezvous, carry propellant versus in-situ propellant production
  - Intermediate launch vehicle (Delta III/Atlas 2AR)
- Technology
  - Low-temperature, low-mass, high-thrust chemical propulsion
  - Possible in-situ propellant production
  - Pinpoint Mars landing using a beacon on the cached sample
  - Extremely low mass, high navigation precision return vehicle
  - Sample packaging and back contamination protection

LOW-MASS AVIONICS REQUIREMENTS FOR MARS SAMPLE RETURN MISSION

MARS ASCENT VEHICLE (MAV)

- Every kg of MAV avionics =>

  > 20 kg MAV mass

  > 45 kg mass on launch pad

- Analysis results in 30 kg allocation for MAV avionics

MARS ORBITER

- Analysis results in 70 kg allocation for orbiter avionics

SPACECRAFT IN A SHOEBOX
(High-top Basketball shoebox size ok)

- Spacecraft avionics for Mars Sample Return and dedicated Nav/Com satellite
- Assumed functionality in a 30 kg package, italics are possible X2000 provided package
  - Low rate commanding and telemetry, including power amp and low-gain antenna
  - Tracking accuracy comparable to current ranging and two-way Doppler at Mars
  - Optical attitude sensing adequate to point a high data rate transmitter
  - 3-axis gyros with drifts less than a few milli-g's, range to 20 g's
  - Computer for attitude control and information handling
  - Valve drive electronics, variable from eight to 16 valves
  - Power distribution
  - Pyro drive electronics
  - Solar panels to power the above plus 15 W for thruster cat beds
  - Secondary battery sized to power the above for one hour, 500 cycles
  - Cabling, structure thermal control (*cabling/structure for X2000 package*)
- Require one year lifetime for 30 kg package
- Same functionality in a 70 kg package with five year lifetime, 2000 cycle battery